J Korean Med Sci 2007; 22: 270-6
ISSN 1011-8934

Clinical Outcome of Urgent Coronary Artery Bypass Grafting

Urgent coronary artery bypass grafting (CABG) has a higher mortality rate than elective CABG. The purpose of this study was to evaluate the clinical outcome of urgent CABG. From July 1992 to May 2005, 104 patients underwent urgent CABG. All patients required an urgent surgical revascularization within 24 hr of diagnostic coronary angiography. In-hospital mortality after urgent CABG was 17.3% (18/104). We compared preoperative characteristics and postoperative clinical outcomes between the survival group (n=86) and the mortality group (n=18). The mean age was 61.7 yr (range, 35-83). The most common cause of mortality was low cardiac output. The independent preoperative risk factors of mortality included advanced age (>70 yr) (OR=3.998, p=0.046), preoperative shock status (OR=6.542, p=0.011), and low ejection fraction (<40%) (OR=4.492, p=0.034). Other risk factors of mortality included prolonged cardiopulmonary bypass time, prolonged ventilator use, and extended intensive care unit stay. The 10-yr actuarial survival rate was 61%. Although the operative mortality rate was high after urgent CABG, a favorable long-term clinical outcome can be expected if the patients survive.

Key Words : *Coronary Artery Bypass Graft; Risk Factors*

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Received : 4 May 2006
Accepted : 25 August 2006

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INTRODUCTION

Clinical outcomes of percutaneous coronary intervention (PCI) have dramatically improved due to the development of new stents. Thus, the age of the population of patients eligible for surgery has increased, and the possibility of belonging in the high risk group has increased as well. Despite this, the outcome of a coronary artery bypass graft (CABG) is excellent. This can be attributed in part to the use of off-pump CABG, the development of minimally invasive surgical techniques, surgery using a robot, and total arterial revascularization. CABG has become one of the safest forms of heart surgery. However, such a favorable clinical outcome can be expected only if the procedure is elective (1-4).

Medical conditions that may require urgent CABG include acute coronary syndrome (ACS). ACS may include clinical conditions such as ongoing myocardial infarction unresponsive to maximal medical treatments, failure of PCI, or cardiogenic shock due to coronary artery diseases. This may be one factor contributing to a high mortality rate.

The purpose of this study were to evaluate the predisposing risk factors prior to and after urgent CABG, to analyze clinical outcome and prognosis, and to characterize risk factors associated with mortality.

MATERIALS AND METHODS

Population

From July 1992 to May 2005, 2,520 patients underwent CABG at our institution. One hundred and four patients (4.1%) who underwent urgent CABG within 24 hr of diagnostic coronary angiography due to medically refractory angina were included in this study. Sixty-four of the patients were male (61.5%), and 40 were female (38.5%). The age of the patients ranged from 35 to 83 yr (average, 61.7±10.2 yr) (Table 1).

Methods

Patient information was reviewed retrospectively based on medical records and outpatient follow-ups. The patients' age at the time of surgery, gender, risk factors, history, diagnosis and surgical indication were reviewed. The left ventricle ejection fraction and the location of the lesion were determined based on coronary angiography and echocardiogram results performed prior to and after surgery. Before 1999, with the use of cardiopulmonary bypass, the aorta was cross-clamped under mild/moderate hypothermia and coronary artery bypass was performed. After 1999, off-pump CABG (OPCAB) was

introduced and depending on the patient, selective off-pump CABG was performed. For each patient, we examined the surgical method, the site of surgery, type and number of grafts used, duration of postoperative mechanical ventilation, duration of intensive care unit (ICU) stay, duration of hospitalization, complications, need for repeat operation, and early death during hospital stay. The survival group and surgical mortality group were compared, and risk factors of mortality were analyzed. This study protocol was reviewed by Institutional Review Board and approved as a minimal risk retrospective study (Approval number: 4-2006-0102) that did not require individual consent based on the institutional guidelines for waiving consent.

Statistics

For statistical analysis, the SPSS 12.0 for windows (SPSS Inc. Chicago, IL, U.S.A.) program was used. The risk factors of operative mortality were analyzed by univariate and multivariated analysis. For the univariated analysis, discrete data were analyzed using chi-square test and continuous data were analyzed using Student's t-test. Table 6 presents the two-by-k crosstab analysis. All descrete and continuous variables, which were significant by univariate analysis, were entered into the multivariate analysis using the logistic regression technique. The data were considered statistically significant if the *p*-value was less than 0.05. The Kaplan-Meier product limit method was used for calculation of actual survival analysis. All data were presented as the mean±standard deviation.

Table 1. Patients demographics

Variables	Number (%)
Sex	
Male	64 (61.5)
Female	40 (38.5)
Age (yr, mean±SD)	61.7±10.2
Risk factor	
Hypertension	53 (51.0)
Diabetes	36 (34.6)
Smoking	46 (44.2)
Family history	15 (14.4)
Hyperlipidemia	14 (13.5)
Obesity	9 (8.7)
Associated disease	
CVA	10 (9.6)
CRF	6 (5.8)
PAOD	5 (4.8)
VHD	5 (4.8)
EF (mean±SD)	41.6±15.0

SD, standard deviation; CVA, cerebral vascular accident; CRF, chronic renal failure; PAOD, peripheral artery occlusive disease; VHD, valvular heart disease; EF, ejection fraction.

RESULTS

Patient characteristics

Thirty-seven patients (35.6%) had left main coronary stenosis, 25 patients (24.0%) had ongoing myocardial infarction unresponsive to medical treatment, 22 patients (21.2%) had failed PCI, and 22 patients (21.2%) had postinfarct ventricular septal defect (VSD). Five patients had ongoing heart failure (4.8%), and one patient developed a recurrent ventricular tachycardia caused by a myocardial infarction. There was one infective endocarditis case (1.0%) (Table 2).

According to preoperative coronary artery angiograms, 37 patients (35.6%) had left main coronary artery disease, 29 had triple vessel disease (27.9%), 17 had two-vessel disease (16.3%), and 16 had single-vessel disease (15.4%) (Table 3). Fifty-eight patients (52.9%) had an acute myocardial infarction (AMI); of those 38 had anterior or anteroseptal infarct, 27 had inferior infarct, and 1 had lateral infarct.

Regarding preoperative risk factors, hypertension was the most common (51%) of the patients afflicted, followed by smoking (44.2%), diabetes mellitus (34.6%), family history (14.4%), hyperlipidemia (13.5%), and obesity (8.7%). Some patients had comorbidities; 10 patients had stroke history (9.6%), six had chronic renal failure (5.8%), five had peripheral artery occlusive disease (4.8%), and five had valvular heart disease (4.8%). Prior to surgery, 31 cases (29.8%) needed intraaortic balloon pump (IABP) support, and 8 cases (7.7%) required cardiopulmonary resuscitation (CPR).

Table 2. Indications for surgery

Cause	Number of patients (%)	Mortality (n=18)
LMD+intractable pain	28 (26.9)	1
AMI+intractable pain	25 (24.0)	4
Failed PCI	22 (21.2)	4
Postinfarction VSD	22 (21.2)	7
Others	7 (6.7)	2

LMD, left main disease; AMI, acute myocardial infarction; PCI, percutaneous coronary intervention; VSD, ventricular septal defect.

Table 3. Preoperative diagnosis

Diagnosis	Number of patients (%)
Left main disease	37 (35.6)
+ 1 VD	4
+ 2 VD	6
+ 3 VD	27
Triple vessel disease	29 (27.9)
Double vessel disease	17 (16.3)
Single vessel disease	16 (15.4)
Acute myocardial Infarction	58 (52.9)
Unstable angina	39 (37.5)
Stable angina	7 (6.7)

VD, vessel disease.

Table 4. Causes of operative mortality

Causes of death	Number of patients (%)
Hospital death	18 (17.3)
Low cardiac output	11
Pneumonia	3
Peritonitis	1
Mediastinitis	1
Ventricular tachycardia	1
Acute respiratory failure	1

In the failed PCI cases (n=22), 16 patients (72.7%) had coronary artery dissection. Two patients had complete coronary artery rupture and left ventricle rupture. The coronary artery occlusion caused the formation of new thrombi, displacement of a stent and rupture of an atherosclerotic plaque in each case.

Operative results

Eighteen patients (17.3%) expired during the hospital stay after urgent CABG. Of those, we had 7 infarct VSD, 4 ongoing AMI, 4 failed PCI, one left main coronary artery disease, one recurrent ventricular arrhythmia, and one endocarditis.

Eleven patients (61.1%) had a severe low EF (mean 30.45±7.54%) before surgery, which resulted in low cardiac output and subsequently death. Three patients with coexisting chronic obstructive pulmonary disease died of multiorgan failure (MOF) after prolonged mechanical ventilation. One patient developed postoperative acute renal failure required peritoneal dialysis and subsequently died of sepsis caused by peritonitis. One patient died of mediastinitis after surgery and one patient died of malignant recurrent ventricular tachycardia. One patient died suddenly due to acute respiratory failure caused by the occlusion of the tracheostomy site with mucous plugs (Table 4). Regarding postsurgical complications, 12 patients (14.8%) developed acute renal failure, and 11 patients (13.6%) developed a superficial wound infection in saphenous vein harvesting site (Table 5).

Twenty-six patients required an IABP both prior to and after surgery; four patients required an IABP after surgery only. The median duration of mechanical ventilation was 21 hr (range, 5-672 hr); the median ICU stay was five days (1-67 days) and the mean hospital stay was 19 days (8-94 days).

Presurgical risk factors of mortality

The univariate predictors of operative mortality were preoperative AMI cases, over 70 yr of age, required IABP, required CPR, shock state at presentation, low EF (<40%), and low NYHA class (Table 6). However, gender and the presence of the main coronary artery lesions were not associated with the mortality rate. Advanced age (>70 yr), preoperative shock status, and low ejection fraction (<40%) were independent predictors of mortality by multivariate logistic regression (Table 7).

Table 5. Postoperative complications

Complication	Number of patients (%)
Renal insufficiency	12 (11.5)
Peripheral wound dehiscence	11 (10.5)
Low cardiac output	11 (10.5)
Mediastinitis	2 (1.9)
Pneumonia	2 (1.9)
Postop. MI	2 (1.9)
CVA	1 (1.0)
UGI bleeding	1
Bed sore	1
Peritonitis	1
Hemothorax	1
Pericardial effusion	1
Empyema	1
VSD patch detachment	1
Peroneal nerve injury	1

MI, myocardial infarction; CVA, cerebral vascular accident; UGI bleeding, upper gastrointestinal bleeding; VSD, ventricular septal defect.

Surgical risk factors of mortality

Eighty-nine patients underwent conventional CABG, and nine patients underwent off-pump CABG. The average surgery time, the duration of the cardiopulmonary bypass time, and the duration of the aorta cross clamping time were 332.8±77.1 (165-570) min, 133.4±62.2 (27-250) min, and 94.6±47.5 (32-202) min, respectively.

Regarding the graft strategy, 43 cases (41.0%) used the left internal mammary artery and great saphenous vein together; 41 cases (39.1%) used only the saphenous vein; 12 cases (13.5%) used both internal mammary artery and saphenous vein; and three cases (2.9%) used both internal mammary artery and the left radial artery. The mean distal anastomosis number was 2.5±1.2 sites (1-5 sites).

Surgical methods, the type of graft, etc. did not statistically alter the outcome. Nevertheless, the duration of the cardiopulmonary bypass time, the duration of the postoperative mechanical ventilation, and the duration of ICU stay did significantly impact the outcome on univariate analyse (Table 6). However, there were no significant correlations on multivariate analyse.

Follow-up

Among the 86 hospital survivors (excluding the 18 hospital deaths), 70 patients were available for follow-up (70/86, 81.4%). The average follow-up period was 36.8±44.0 (1-145) months. The 10-yr survival rate of the patients was 61% (Fig. 1).

Table 6. Urgent CABG operative mortality risk factors

Variables	No. of patients	Death	*p*-value
Age			0.000*
>70	28	11	
<70	76	7	
Sex			0.372
Male	64	10	
Female	40	8	
Hypertension			0.599
(+)	53	10	
(-)	46	8	
Missing	5		
Diabetes			0.438
(+)	36	8	
(-)	63	10	
Missing	5		
Hyperlipidemia			0.555
(+)	14	2	
(-)	85	16	
Missing	5		
Ejection fraction			0.005*
>40	40	2	
<40	46	16	
Missing	18		
NYHA			0.002*
I	1	0	
II	25	1	
III	36	4	
IV	41	13	
Missing	1		
Preop. AMI			0.001*
(+)	58	16	
(-)	46	2	
Preop. shock			0.000*
(+)	40	15	
(-)	61	3	
Missing	3		
Preop. IABP			0.006*
(+)	31	11	
(-)	70	7	
Missing	3		
Preop. CPR			0.004*
(+)	8	6	
(-)	91	12	
Missing	5		
LMD			0.133
(+)	37	4	
(-)	67	14	
Operation			0.876
CABG	89	17	
OPCAB	9	1	
Missing	6		
Bypass time (min)			0.014*
<=120	30	1	
121-180	44	8	
>180	21	9	
Missing	9		
ACC time (min)			0.117
<=60	15	2	
60-120	55	6	
>120	25	7	
Missing			
Ventilator time (hr)			0.000*
<=24	48	0	
>24	37	9	
Missing	10		
ICU stay (days)			0.001*
<=7	62	3	
>7	30	10	
Missing	7		

CABG, Coronary Artery Bypass Grafting; Preop., preoperative; NYHA, New York Heart Association; AMI, acute myocardial infarction; IABP, Intraaortic balloon pump; CPR, Cardiopulmonary resuscitation; LMD, Left main disease; OPCAB, Off -pump coronary artery bypass; ACC, Aortic cross clamping; ICU, Intensive care unit. *, $p<0.05$.

Table 7. Multivariate anayse for risk factors of mortality

Variables	OR	95% CI	*p*-value
Age (>70)	3.998	0.029-0.965	0.046*
EF (<40)	4.492	0.004-0.809	0.034*
Shock	6.542	0.005-0.499	0.011*
AMI	1.763	0.029-1.969	0.184
IABP use	2.494	0.675-38.76	0.114
NYHA	0.386	0.046-13.44	0.943
CPR	0.042	0.121-5.518	0.837

OR, odds ratio; CI, confidence interval; EF, ejection fraction; AMI, acute myocardial infarction; IABP, intraaortic balloon pump; NYHA, New York Heart Association; CPR, cardiopulmonary resuscitation. *, $p<0.05$.

DISCUSSION

There were many studies on risk factors in urgent CABG in western countries. However, only several studies were found in Asia (1, 12-15, 19). Our study, is based on single-hospital experience involving a relatively large population. It is noteworthy to mention that our study was different from other reported studies in Asia.

The standard timeframe for urgent surgery varies depending on different reports. Treatment within 24 hr of patient decompensation or within six hours of an unfavorable coronary artery angiogram is considered as the standard (2, 8, 15, 19). In our study, surgery was performed within six hours in most cases (86%). Several cases (endocarditis, failed PCIs) were transferred from other medical institutions and surgery was able to be performed within 24 hr in most cases. Therefore, in our study, 24 hr was considered the standard timeframe.

In other studies, severe stenosis in the left main coronary artery has been reported to be the most common indication for surgery (13, 19). In such patients, the left main coronary

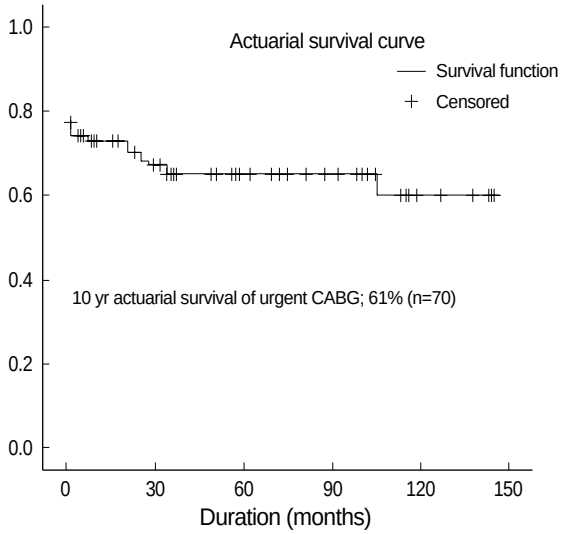

Fig. 1. Kaplan-Meier survival curve.

artery demonstrated an average stenosis of 76.0%. However, in our study the left main coronary artery lesion was not a risk factor of surgical mortality (p=0.133).

Twenty-two cases (21.2%) required urgent CABG as a result of an acute coronary dissection or occlusion secondary to PCI failure. Recently, with the development of stents, the number of urgent CABG after failed PCI has declined. However, the incidence has been reported between 1.5% and 2% (5). Similarly, in our hospital during the study period, a total of 5,714 PCIs were performed; 84 of those cases (1.4%) proved unsuccessful. Among them only 22 patients (22/84, 26.2%) underwent urgent surgery. Among the failed PCIs, four patients died postoperatively (4/22, 22.2%); this is higher than the total operative mortality rate 17.3%. Although patients consider PCI to be safer than surgery, this is not always the case. When PCI fails, immediate urgent surgery could lower the mortality rate (6). In light of this, PCI intervention by cardiologist should be performed in a hospital where emergency surgery is available. In order to decrease morbidity and mortality, careful selection of patients is required and as a principle of performing PCI, surgical consideration should be made in all cases. In cases that develop complications, there should be immediate and aggressive surgical intervention.

According to the Worcester and Mass study on cardiogenic shock patients with accompanying AMI, it has been reported that, between the years of 1975 and 1988, the incidence was 7.5%, and in the cases treated with only medically, there was an 80% mortality rate (7, 8). This ratio did not change depending on yr evaluated. Despite advancements in cardiac surgery over the past 10 yr (i.e., the development of surgical techniques, improvement in the myocardial protection method and the development of mechanical assist device or equipment) there was no overall improvement in the mortality rate (Table 8). We divided the whole study period into three groups and compared the mortality, but there was no significant difference between groups (p=0.790).

Table 8. Surgical outcomes by year

Year	Number of patients	Number of death	*p*-value
1992-1995	31	6	0.790
1996-2000	33	6	
2001-2005	40	6	

The purpose of the urgent CABG is to reperfuse the coronary artery blood flow rapidly, improve areas of myocardial ischemia, repair ventricular dysfunction, and prevent the spread of the infarction area (1, 3, 9-11). In our study, 58 cases (52.9 %) had an AMI, 39 had unstable angina pectoris (37.5%), and 7 had stable angina pectoris (6.7%). Of those AMI patients, 16 patients (27.6%) died. Only two (5.1%) of the unstable angina pectoris patients died. In other studies involving urgent CABG in AMI patients, early mortality rates ranged from 8.5% to 39%, which was higher than other patient groups. Cardiogenic shock, left main coronary artery lesion, and advanced patient age have been reported to be prognostic risk factors (12, 13).

In cases involving patients older than 70 yr of age, ongoing AMI, the use of an IABP, the need for CPR, preoperative shock state and low ejection fraction, there was a statistically close association with an early mortality rate on univariate analyse. These risk factors have already been reported in other studies (3, 12-16). Among them advanced age (>70 yr), preoperative shock status, and low ejection fraction (<40%) were identified independent risk factors of mortality by multivariate logistic regression (Table 7). It is thought that these risk factors reflect the cardiac function of the patient prior to surgery. Indeed, among the eleven (61.1%) postoperative deaths, left ventricular failure due to the low cardiac output persisted postoperatively, and the patients eventually developed MOF. Due to prolonged respirator use and decreased immunity, sepsis developed in one patient resulting in death. This implies that the presurgical hemodynamic condition of a patient is very important. Therefore, it is thought that establishing hemodynamic stability in conjunction with the cardiologist prior to surgery significantly influences surgical outcome.

Gender ratio, the presence or absence of a left main coronary artery lesion, hypertension, diabetes or hyperlipidemia was not associated with the mortality rate.

Statistical significance regarding surgical methods or the choice of graft was not obtained. However, recently, with the development of IABP or percutaneous cardiopulmonary support system (PCPS), patients are stabilized preoperatively. Off-pump CABG is on the rise, as well as the use of arterial grafting.

The time required to harvest the internal mammary artery is longer than that required to harvest the great saphenous vein. The initial blood flow rate and reperfusion is higher in

urgent CABG involving the saphenous vein. Hence, the use of the saphenous vein was preferred (17). However, it has been reported that the mortality rate did not differ according to the vessel used in urgent CABG (18, 19). Similarly, in our hospital, arterial grafts were not used prior to 1994. After this time period, arterial grafts were used aggressively, and are currently used in patients who are hemodynamically stable and undergoing off-pump CABG. In fact, in nine recent cases performed OPCAB, the mortality rate within 30 days of surgery was zero. However, since the number of cases was not sufficient, it could not be statistically compared with conventional CABG.

After urgent CABG, complications developed in 36 of the 86 cases (34.6%), excluding those patients who had expired. Such complications were considered to be unrelated to survival; however, they are important predictive factors in determining clinical outcomes. Twelve patients experienced renal failure due to the pre- and postoperative shock state (14.0%). Eleven patients developed a superficial wound infection in the area where the saphenous vein had been harvested (12.8 %). Such complications might have developed as a result of insufficient evaluation before surgery; nonetheless, in many cases it could be prevented by the careful medical treatment. It is thought that in urgent cases, similarly to elective patients, the status of the patients' health before and after surgery may contribute to the quality of life of the patient. To obtain a good clinical outcome, collaboration with the cardiologists is necessary in order to stabilize preoperative hemodynamic condition via IABP or PCPS. However, in cases unresponsive to medical management, or in the failed PCI cases, it is important to perform emergent surgery, before the hemodynamic condition of the patient deteriorates irreversibly.

In conclusion, the present study demonstrated that independent risk factors of mortality included advanced age (>70 yr), preoperative shock status, and low ejection fraction (<40 %). Despite the higher surgical mortality rate (17.3%) after the urgent CABG, a favorable long-term clinical outcome can be expected if the patients survive.

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